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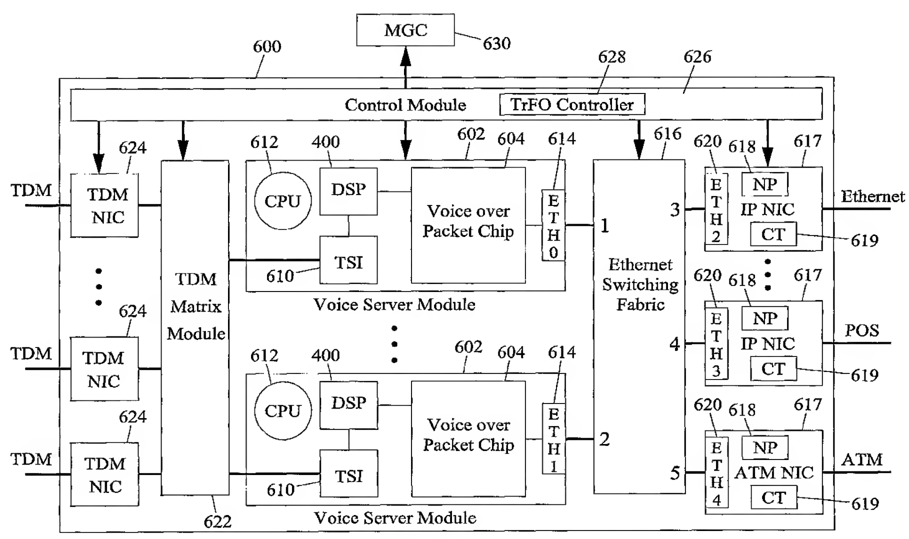
(54) **Title:** METHODS, SYSTEMS, AND COMPUTER PROGRAM PRODUCTS FOR SUPPORTING TRANSCODER-FREE OPERATION IN MEDIA GATEWAY



(57) **Abstract:** Methods, systems, and computer program products for providing transcoder-free operation in a media gateway are disclosed. In one method, first and second lists of media encoding rates and corresponding indices used by first and second media endpoints of a media stream connection are received. It is determined whether transcoder-free operation is possible for the media stream connection based on the first and second lists. In response to determining that transcoder-free operation is possible for the media stream connection, a transcoder-free connection is established in the media gateway between the first and second endpoints using a single digital signal processor to monitor and map between indices and encoding rates used by the first and second endpoints during the media stream connection.

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DESCRIPTION

METHODS, SYSTEMS, AND COMPUTER PROGRAM PRODUCTS FOR SUPPORTING TRANSCODER-FREE OPERATION IN MEDIA GATEWAY

RELATED APPLICATIONS

This application claims the benefit of U.S. Patent Application Serial No. 11/207,572, filed August 19, 2005, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The subject matter described herein relates to implementing transcoder-free operation in a telecommunications network. More particularly, the subject matter described herein relates to methods, systems, and computer program products for implementing transcoder-free operation in a media gateway.

BACKGROUND ART

In telecommunications networks, codecs are devices that encode and decode voice signals transmitted over the network. Conventionally, uniform pulse code modulation (PCM) was used to encode voice sent over the telecommunications network. Uniform PCM involves sampling voice signals at a rate of 8,000 samples per second and 8 bits per sample, resulting in a 64 kbps codec rate. More recently, in mobile communications networks, adaptive modulation rate (AMR) codecs have been developed in which encoding and decoding rates change during a call. AMR is used to reduce the bandwidth used by voice calls.

One problem associated with using AMR codecs or other different types of codecs is that transcoding may be required when the source and destination devices use incompatible codecs. Transcoding is a process by which a voice signal encoded according to one rate and encoding standard is converted to another rate and another encoding standard. One problem with performing transcoding is that it can introduce latency and degradation in the voice signal being transmitted.

Figure 1 is a block diagram illustrating transcoders performing transcoding of a speech signal in a telecommunications network. Referring to Figure 1, a first transcoder **100** receives an AMR voice signal at an IuUP or NbUP interface of a 3GPP UMTS network. Transcoder **100** performs a transcoding operation by which the AMR voice signal is converted to PCM and forwards the signal to transcoder **102**. Transcoder **100** introduces latency and voice degradation into the signal. The latency and voice degradation introduced by transcoder **100** is indicated by T_1 in Figure 1.

Transcoder **102** receives the PCM signal from transcoder **100** and performs a second transcoding operation, converting the PCM signal to AMR rate 1, the same AMR rate received by the first transcoder. Transcoder **102** introduces further latency and voice quality degradation into the signal. The latency and voice quality degradation introduced by transcoder **102** is indicated by T_2 in Figure 1. In the example illustrated in Figure 1, because the ingress and egress AMR rates are equal, transcoding is unnecessary. However, transcoding is performed because no intelligence exists in the network illustrated in this example to eliminate transcoding.

In order to avoid the difficulties associated with transcoding, methods for transcoder-free operation have been developed. Transcoder-free operation refers to operation in which a connection that is established between telecommunications endpoints, such as mobile telephones, that have compatible codecs where the connection does not use transcoders. Figure 2 is a block diagram of a conventional transcoder-free operation implementation developed by the assignee of the present application for use in a media gateway, referred to as the SanteraOne™ media gateway. Referring to Figure 2, media gateway **200** includes a plurality of packet network interfaces **202** for interfacing core networks, such as radio network control (RNC)/core network **205**, that interface with voice over IP devices, such as mobile phones **204**, an ATM switching fabric **206**, voice servers **208**, a TDM matrix **210**, and TDM network interfaces **212**. ATM switching fabric **206** establishes connections between packet network interfaces **202** and voice servers **208**. Voice servers **208** perform voice processing functions, such as transcoding, encoding, and decoding. In the illustrated example, each voice server **208** includes a DSP

214 that implements a codec function. TDM matrix **210** switches TDM channels between TDM network interfaces **212** and voice servers **208**. TDM matrix **210** also includes an HDLC bus **216** that interconnects DSPs on different voice servers. TDM network interfaces **212** interface with TDM based telecommunications endpoints.

In the example illustrated in Figure 2, in order to implement a transcoder-free connection, two codecs and two HDLC channels are used. That is, one DSP **214** on voice server **108** monitors the rate of an encoder used by a first telecommunications endpoint and the other DSP **214** on a separate voice server card monitors the encoding rate being used by the other endpoint. Rates and rate changes are communicated between the codecs using the HDLC connections. No transcoding is performed by either voice server because the ingress and egress codec rates are the same.

One problem associated with the transcoder-free operation of the media gateway **200** illustrated in Figure 2 it requires separate DPSs to monitor each endpoint of the connection Another problem is that the DSPs must be interconnected using two HDLC connections. Establishing each HDLC connection requires complex connection establishment procedures.

Thus, in light of these difficulties associated with providing transcoder-free operation in media gateway, there exists a need for improve methods, systems, and computer program products for providing transcoder-free operation in a media gateway.

SUMMARY

According to one aspect, the subject matter described herein includes a method for implementing transcoder-free operation in a media gateway. The method includes receiving lists of media encoding rates and corresponding indices used by first and second endpoints of a media stream connection. Next, it is determined whether transcoder-free operation is possible for the media stream connection. In response to determining that transcoder-free operation is possible, a transcoder-free connection is established in the media gateway between the first and second endpoints using a single digital signal

processor to monitor and map between indices and encoding rates used by the first and second endpoints during the media stream connection.

According to another aspect, a method for implementing transcoder-free operation in a media gateway includes receiving first and second lists of media encoding rates and corresponding indices used by first and second media endpoints of a media stream connection. Next, it is determined whether transcoder-free operation is possible. In response to determining that transcoder-free operation is possible, a transcoder-free connection is established in the media gateway over an Ethernet switching fabric.

The subject matter described herein may be implemented using a computer program product comprising computer executable instructions embodied in a computer readable medium. Exemplary computer readable media suitable for implementing the subject matter described herein include chip memory devices, disc memory devices, application specific integrated circuits, programmable logic devices, and downloadable electrical signals. In addition, a computer program product that implements a subject matter described herein may reside on a single device or computing platform or maybe distributed across multiple devices or computing platforms.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the subject matter described herein will now be explained with reference to the accompanying drawings of which:

Figure 1 is a block diagram illustrating transcoding in a telecommunications network;

Figure 2 is a block diagram illustrating a conventional transcoder-free operation implementation in a media gateway;

Figure 3 is a flow chart illustrating a method for implementing transcoder-free operation in a media gateway according to an embodiment of the subject matter described herein;

Figure 4 is a block diagram illustrating exemplary components for implementing transcoder-free operation in a media gateway according to an embodiment of the subject matter described herein;

Figure 5 is a block diagram illustrating an exemplary transcoder-free operation (TrFO) over Ethernet protocol stack that may be implemented in a media gateway according to an embodiment of the subject matter described herein;

Figure 6 is a block diagram of a media gateway including an Ethernet switching fabric for implementing transcoder-free operation according to an embodiment of the subject matter described herein;

Figure 7 is a block diagram illustrating an exemplary method for implementing transcoder-free operation in a media gateway according to an embodiment of the subject matter described herein; and

Figure 8 is a block diagram illustrating an alternate method for implementing transcoder-free operation in a media gateway according to an embodiment of the subject matter described herein.

DETAILED DESCRIPTION OF THE INVENTION

According to one aspect, the subject matter described herein includes a method for implementing transcoder-free operation in a media gateway. Figure 3 is a flow chart illustrating the exemplary steps for implementing transcoder-free operation in a media gateway according to an embodiment of the subject matter described herein. Referring to Figure 3, in step **300**, lists of media encoding rates and corresponding indices used by endpoints of a media stream connection are received. These lists may be received by the control module of the media gateway. The control module may forward the lists to an internal processor associated with controlling voice processing functions of the media gateway. In step **302**, the internal processor determines whether transcoder-free operation is possible. Determining whether transcoder-free operation is possible may include examining ingress and egress codec rates to determine whether the rates are compatible.

In step **304**, if it is determined that transcoder-free operation is not possible, control proceeds to step **306** where a connection with transcoding is established between endpoints over an Ethernet switching fabric. In step **304**, if it is determined that transcoder-free operation is possible, control proceeds to step **308** where a transcoder-free operation connection is established between

endpoints over the Ethernet switching fabric in a media gateway using a single DSP to monitor and vary encoding rates.

Figure 4 is a block diagram illustrating exemplary components for providing transcoder-free operation in a media gateway according to an embodiment of the subject matter described herein. Referring to Figure 4, a codec/DSP **400** implements an IuUP/NbUP protocol stack **402** for both endpoints of a connection and performs radio access bearer sub-flow combination indicator (RFCI) mapping for a transcoder-free operation connection. A single DSP **400** is used to implement the transcoder-free operation. A second codec, such as that illustrated in Figure 2, is not utilized. As a result, the solution illustrated in Figure 4 reduces the resources required to implement transcoder-free operation in a media gateway. In addition, connections between the endpoints and codec **400** are established over an Ethernet switching fabric, schematically illustrated in Figure 4 by dual arrows **404**.

Figure 5 is a block diagram illustrating protocol stack **402** in more detail. In Figure 5, protocol stack **402** includes a first IuUP/NbUP layer **500** and a first Ethernet interface layer **502** for interfacing with one endpoint of a TrFO connection. In addition, protocol stack **402** includes a second IuUP/NbUP layer **504** and second Ethernet interface layer **506** for interfacing with the other endpoint of a TrFO connection. An RFCI mapping layer **508** maps between codec rates used by the different endpoints of a TrFO connection. It should be noted that layers **500**, **504**, and **508** may be implemented by a DSP. It should be noted from Figure 5 that a single DSP **400** is used to implement the IuUP/NbUP layers for each endpoint of a connection as well as to perform the RFCI mapping. Ethernet interface layers **502** and **506** may be implemented a an Ethernet interface that connects the DSP to an Ethernet switching fabric. Using a single DSP to perform AMR rate monitoring and RFCI mapping reduces the resources required to implement TrFO in a media gateway over the implementation illustrated in Figure 2.

Figure 6 is a block diagram illustrating a media gateway for implementing transcoder-free operation according to an embodiment of the subject matter described herein. The architecture illustrated in Figure 6

corresponds to a media gateway having an Ethernet switching fabric, as described in commonly-assigned, co-pending U.S. patent application no. 11/138,990, filed May 26, 2005, the disclosure of which is incorporated herein by reference in its entirety. Referring to Figure 6, media gateway **600** includes a plurality of voice servers **602** for performing voice processing functions. In the illustrated example, each voice server **602** includes a voice over packet chip **604**, a time slot interconnection **610**, CPU **612**, DSP **400**, and an Ethernet interface **614**. Voice over packet chip **604** encapsulates and removes voice information from IP packets and forwards the information to DSP **400** for further processing. Voice over packet chip **604** may also perform ATM adaptation layer one and layer two functions, respectively. DSP **400** performs transcoding, echo-cancellation, and other payload translation functions. According to an aspect of the subject matter described herein, each DSP **400** may implement the IuUP/NbUP protocol stack with RFCI mapping described above. TSI **610** makes on demand connections between voice over IP chip channels, TDM matrix channels and DSPs. CPU **612** controls the overall operation of each voice server module **602**. Ethernet interfaces **614** connect each voice server module **602** with other modules that are connected to an Ethernet switching fabric **616**.

Media gateway **600** also includes broadband network interfaces **617** that connect media gateway to external networks for receiving media packets from the networks. Broadband network interfaces **617** may include IP network interfaces as well as ATM network interfaces. Each broadband network interface **617** may include a network processor **618**, a connection table **619**, and an internal Ethernet interface **620**. Network processors **618** control the overall operation of each broadband network interface **617**. For example, network processors **618** may control the writing of data to each connection table **618**. Each connection table **619** maintains connection data for forwarding media packets to the correct voice server. Internal Ethernet interfaces **620** connect each broadband network interface **617** to Ethernet switching fabric **616**.

Ethernet switching fabric **616** interconnects voice server **602** and broadband interface **617**. In the illustrated example, Ethernet switching fabric

616 includes a plurality of ports, numbered one through five. Five ports are shown for illustrative purposes only. It is understood that Ethernet switching fabric **616** may include fewer or more than five ports, depending on the number of devices connected to Ethernet switching fabric **616**.

Media gateway **600** also includes a TDM matrix module **622** for switching TDM time slots between TDM network interfaces **624** and voice servers **602**. TDM network interfaces **624** connect media gateway **600** to external TDM devices, such as TDM enabled end offices.

A control module **626** controls the overall operation of media gateway **600**. In the illustrated example, control module **626** includes a TrFO controller **628** for receiving information from CPUs **612** of each voice server module regarding ingress and egress encoding rates and indices, determining whether TrFO is possible, and instructing voice server module **602** and network interfaces **617** to implement TrFO over Ethernet switching fabric **616**. Control module **626** also communicates with an external media gateway controller **630**. Media gateway controller **630** controls the establishment of connections by media gateway **600** using a media gateway control protocol, such as MEGACO or MGCP.

Figure 7 is a block diagram illustrating exemplary steps for achieving TrFO in media gateway **600** according to one embodiment of the subject matter described herein. Referring to Figure 7, a first media stream connection (labeled 1) is established between a first network endpoint, such as a node in RNC/core network **205** that interfaces directly or indirectly with a first mobile phone **700**, and a first voice server **602A**. A second media stream connection (labeled 2) is established between the second endpoint, such as a node in RNC/core network **205** that interfaces directly or indirectly with mobile phone **702**, and a second voice server **602B**. A third media connection (labeled 3) is established between broadband interface card **617** and voice server card **602B**. Once the control module determines a transcoder-free operation is possible, the control module instructs broadband interface card **617** to replace connection 1 with connection 3. Replacing connection 1 with connection 3 may include instructing broadband interface card **617** to update its connection table **619** to reflect the new connection for the call. In addition, replacing connection

1 with connection 3 may include instructing voice server **602B** to implement the NbUP/IuUP protocol stack and RFCI mapping function described above.

Tables 1 and 2 shown below illustrate the status of connection table **619** of broadband network interface card **617** before and after transcoder free operation is implemented. Tables 1 and 2 each include a first column indicating the external or network VPI/VCI value associated with incoming ATM cells that carry voice. The second column in each table includes a new VPI/VCI value used internally between the voice server cards and the network interfaces. The third column includes the voice server MAC address corresponding to the connection. It can be seen that in Table 1, before transcoder-free operation is established, the connection to each endpoint includes a separate voice server MAC address. In Table 2, after transcoder free operation is implemented, the voice server MAC address corresponding to both endpoints of the connection is Ethernet address ETH1, which corresponds to a single voice server card.

External VPI/VCI	New VPI/VCI	Voice Server MAC Addr.
100/1	110/1	Eth 0
100/2	110/2	Eth 1

Table 1: Broadband Interface Connection Table Before TrFO

External VPI/VCI	New VPI/VCI	Voice Server MAC Addr.
100/1	110/3	Eth 1
100/2	110/2	Eth 1

Table 2: Broadband Interface Connection Table After TrFO

An important function performed by a DSP once a TrFO connection is established is RFCI mapping. In order to perform such mapping, the DSP may maintain separate RFCI values for each connection endpoint. Tables 3 and 4 shown below are examples of RFI values that may be maintained by a DSP on a voice server card according to an embodiment of the subject matter described herein.

Channel Index	Rate
1	12.2k
2	10.2k
3	7.95k
4	6.7k

Table 3: RFCI Values and Rates for Endpoint A

Channel Index	Rate
5	12.2k
6	10.2k
7	7.95k
8	6.7k

Table 3: RFCI Values and Rates for Endpoint B

From Tables 1 and 2, the channel index and the corresponding rates for each endpoint can be determined. Once the DSP knows the indices and corresponding rates, the DSP can perform mappings between indices used by different endpoints. In the examples illustrated in Tables 3 and 4, the mappings would be 1-5, 2-6, 3-7, and 4-8.

Figure 8 is a block diagram illustrating an alternate method for implementing TrFO in a media gateway according to an embodiment of the subject matter described herein. Referring to Figure 8, a first media stream connection (labeled 1) is established between the endpoint that connects to mobile phone **700** and voice server **602A**. A second media connection (labeled 2) is established between the endpoint that connects to mobile phone **702** and voice server **602B**. Once TrFO controller **628** (illustrated in Figure 6) that determines transcoder-free operation is possible, TrFO controller **628** instructs voice server **602A** to perform a loop back function and to initiate a connection (labeled 3) with voice server **602B**. Implementing a loop back connection at voice server **602A** means that the DSP on voice server **602A** is not impacted. Thus, even though the solution illustrated in Figure 8 requires two voice servers, DSP processing resources are conserved over conventional TrFO implementations in media gateway, because DSP resources on the voice server where the loop back is implemented are not used.

Thus, the subject matter described herein includes methods, systems, and computer program products for implementing TrFO in media gateway. The subject matter includes utilizing a single DSP that implements an IbUP/NbUP protocol stack and RFCI mapping for both ends of a TrFO connection. In addition, the TrFO connection is established over an Ethernet switching fabric. Because only a single DSP is required, DSP processing resources are conserved over conventional TrFO implementations. Because an Ethernet switching fabric is used instead of an ATM switching fabric, the cost and complexity of the media gateway are reduced.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation, as the invention is defined by the claims as set forth hereinafter.

CLAIMS

What is claimed is:

1. A method for implementing transcoder-free operation in a media gateway, the method comprising:
   (a) receiving first and second lists of media encoding rates and corresponding indices used by first and second media endpoints of a media stream connection;
   (b) determining whether transcoder-free operation is possible for the media stream connection based on the first and second lists; and
   (c) in response to determining that transcoder-free operation is possible for the media stream connection, establishing a transcoder-free connection in the media gateway between the first and second endpoints using a single digital signal processor (DSP) to monitor and map between indices and encoding rates used by the first and second endpoints during the media stream connection.
2. The method of claim 1 wherein receiving first and second lists of media encoding rates and corresponding indices includes receiving first and second lists of radio access bearer sub-flow combination indicators (RFCIs) and corresponding media encoding rates used by the first and second endpoints.
3. The method of claim 1 wherein determining whether transcoder-free operation is possible includes determining whether the media encoding rates in the first list are compatible with those in the second list.
4. The method of claim 1 wherein establishing a transcoder-free connection includes establishing a first connection between the first endpoint and a first voice server, establishing a second connection between the second endpoint and a second voice server, and replacing the second connection with a third connection between the second endpoint and the first voice server.
5. The method of claim 1 wherein establishing a transcoder-free connection includes establishing a first connection between the first endpoint and a first voice server, establishing a second connection

between the second endpoint and a second voice server, and establishing a loop back connection between the first and second voice server.

6. The method of claim 1 wherein establishing a transcoder-free connection includes establishing a transcoder-free connection over an Ethernet switching fabric in the media gateway.

7. The method of claim 1 comprising, after establishing the transcoder-free connection, performing radio access bearer sub-flow combination indicator (RFCI) mapping for the connection.

8. A method for implementing transcoder-free operation in a media gateway, the method comprising:

   (a) receiving first and second lists of media encoding rates and corresponding indices used by first and second media endpoints of a media stream connection;

   (b) determining whether transcoder-free operation is possible for the media stream connection based on the first and second lists; and

   (c) in response to determining that transcoder-free operation is possible, establishing a transcoder-free connection over an Ethernet switching fabric in the media gateway.

9. The method of claim 8 wherein receiving first and second lists of media encoding rates and corresponding indices includes receiving first and second lists of radio access bearer sub-flow combination indicators (RFCIs) and corresponding media encoding rates used by the first and second endpoints.

10. The method of claim 8 wherein determining whether transcoder-free operation is possible includes determining whether the media encoding rates in the first list are compatible with those in the second list.

11. The method of claim 8 wherein establishing a transcoder-free connection includes establishing a first connection between the first endpoint and a first voice server, establishing a second connection between the second endpoint and a second voice server, and replacing the second connection with a third connection between the second endpoint and the first voice server.

12. The method of claim 8 wherein establishing a transcoder-free connection includes establishing a first connection between the first endpoint and a first voice server, establishing a second connection between the second endpoint and a second voice server, and establishing a loop back connection between the first and second voice servers.

13. The method of claim 8 comprising, after establishing the transcoder-free connection, performing radio access bearer sub-flow combination indicator (RFCI) mapping for the connection.

14. A media gateway comprising:
    (a) a broadband interface for sending media packets to and receiving media packets from an external network;
    (b) a packet switching fabric for forwarding media packets between the broadband interface and at least one internal processing resource in the media gateway;
    (c) at least one voice server for performing voice processing functions, including transcoding, for the media packets; and
    (d) a transcoder-free operation controller for establishing a transcoder-free connection between the broadband interface and the voice server via the switching fabric.

15. The media gateway of claim 14 wherein the broadband interface comprises an IP interface.

16. The media gateway of claim 14 wherein the broadband interface comprises an ATM interface.

17. The media gateway of claim 14 wherein the packet switching fabric comprises an Ethernet switching fabric.

18. The media gateway of claim 14 wherein the packet switching fabric comprises an ATM switching fabric.

19. The media gateway of claim 14 wherein the at least voice server includes a single DSP for monitoring and mapping between indices and encoding rates used by endpoints of the transcoder-free connection.

20. The media gateway of claim 14 wherein the transcoder-free operation controller is adapted to determine whether transcoder-free operation is

possible by examining encoding rates used by endpoints of a connection.

21. The media gateway of claim 14 wherein the voice server is adapted to perform radio access bearer sub-flow combination indicator (RFCI) mapping for the transcoder-free connection.

22. A computer program product comprising computer executable instructions embodied in a computer readable medium for performing steps comprising:

(a) receiving first and second lists of media encoding rates and corresponding indices used by first and second media endpoints of a media stream connection;

(b) determining whether transcoder-free operation is possible for the media stream connection based on the first and second lists; and

(c) in response to determining that transcoder-free operation is possible for the media stream connection, establishing a transcoder-free connection in the media gateway between the first and second endpoints using a single digital signal processor (DSP) to monitor and map between indices and encoding rates used by the first and second endpoints during the media stream connection.

23. A computer program product comprising computer executable instructions embodied in a computer readable medium for performing steps comprising:

(a) receiving first and second lists of media encoding rates and corresponding indices used by first and second media endpoints of a media stream connection;

(b) determining whether transcoder-free operation is possible for the media stream connection based on the first and second lists; and

(c) in response to determining that transcoder-free operation is possible, establishing a transcoder-free connection over an Ethernet switching fabric in the media gateway.

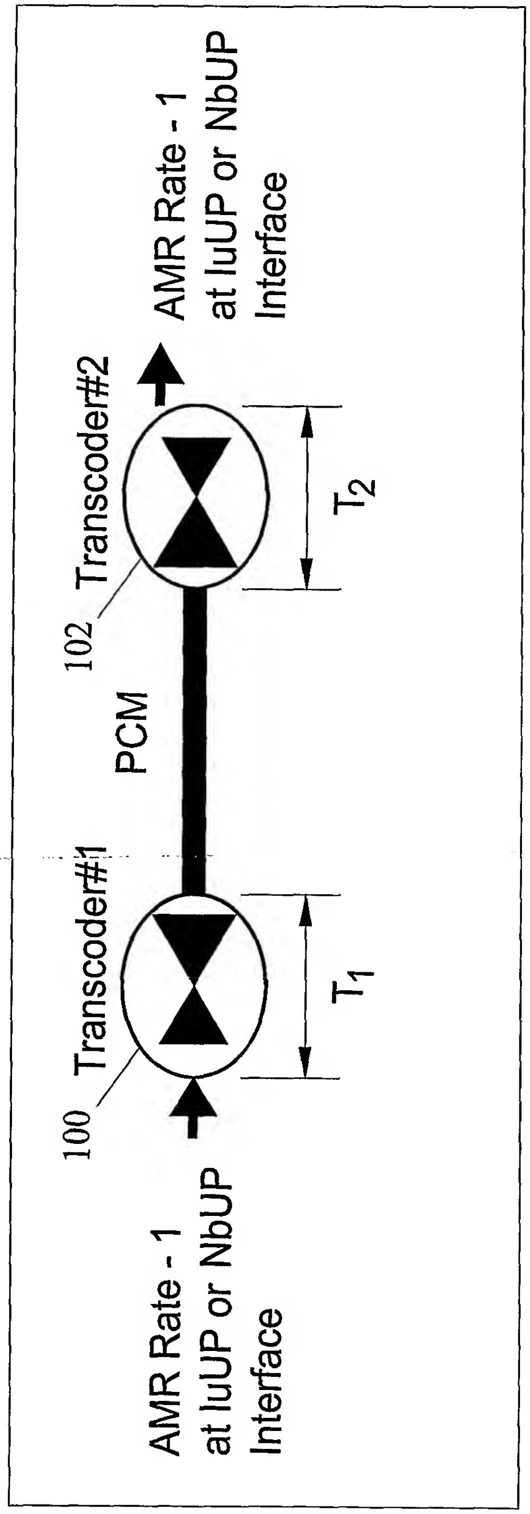


FIG. 1
(Prior Art)

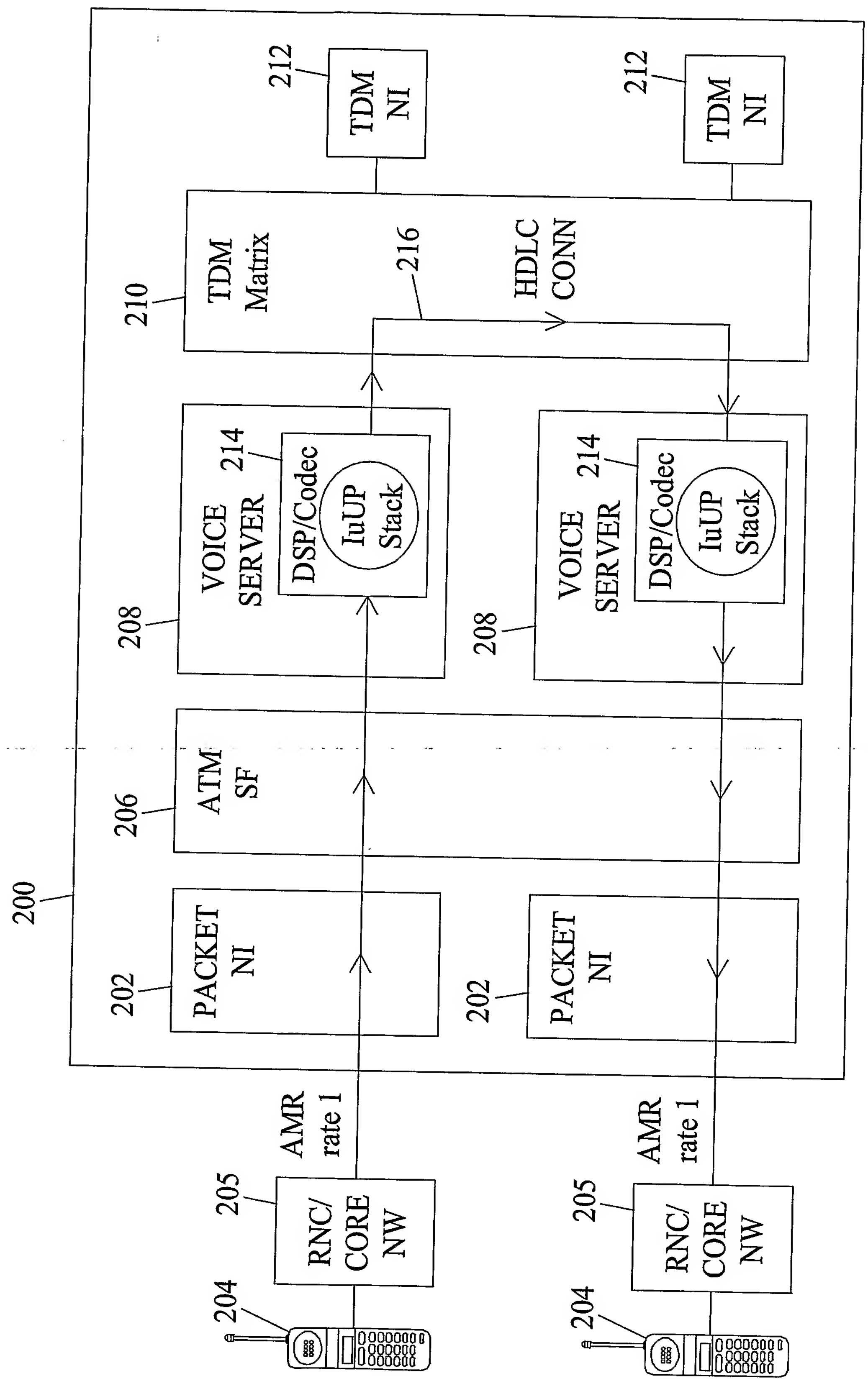


FIG. 2
(Prior Art)

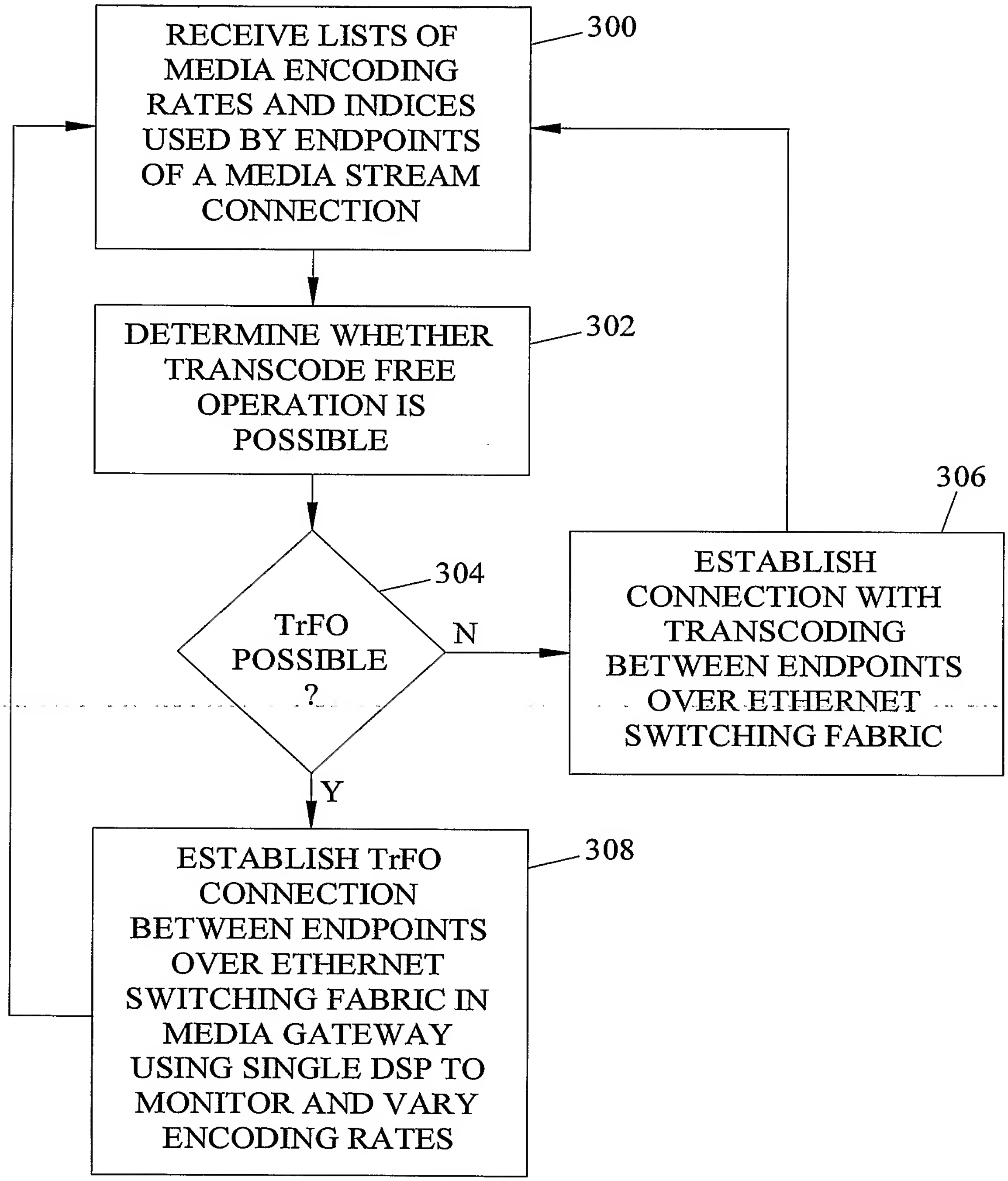
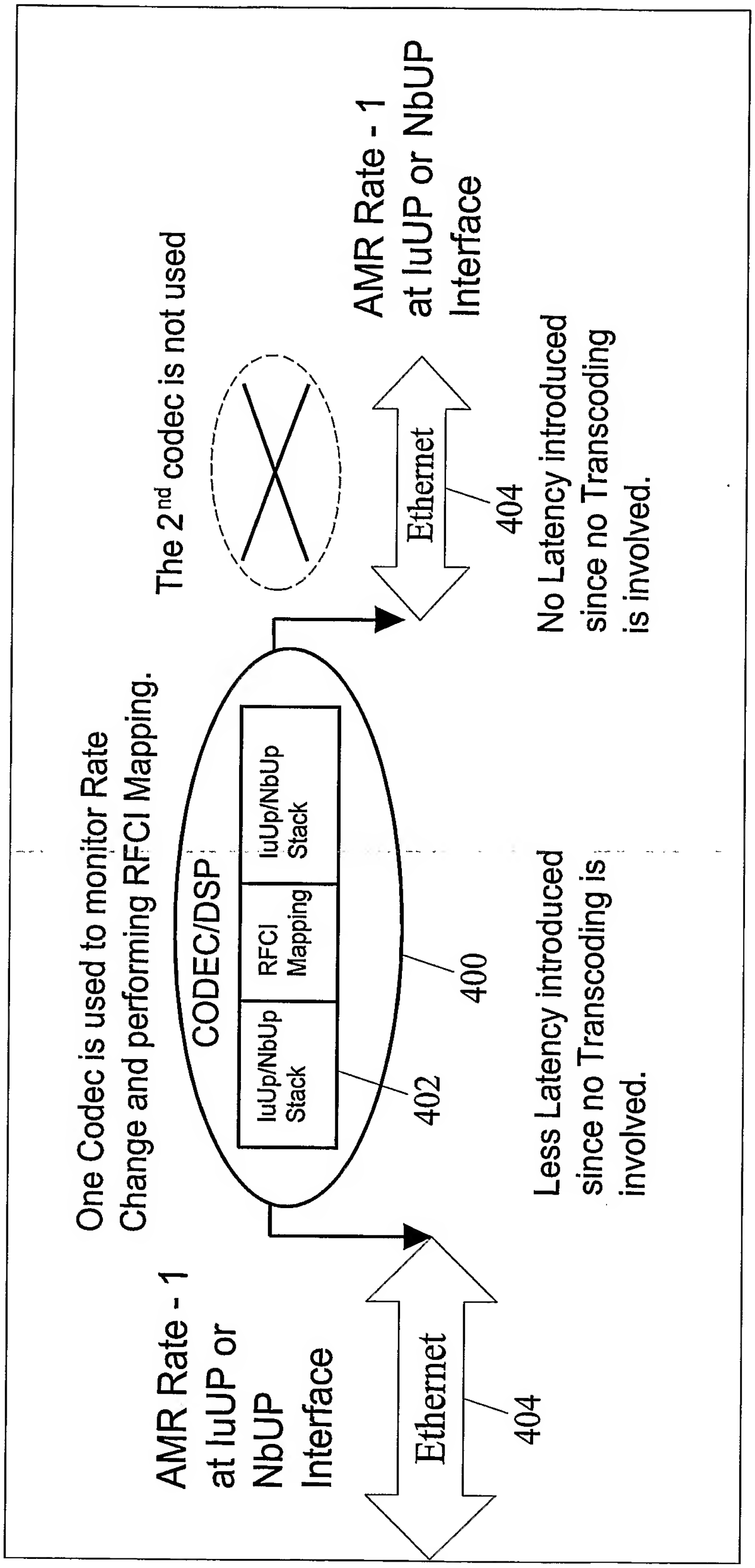

RECEIVE LISTS OF MEDIA ENCODING RATES AND INDICES USED BY ENDPOINTS OF A MEDIA STREAM CONNECTION
300
DETERMINE WHETHER TRANSCODE FREE OPERATION IS POSSIBLE
302
TrFO POSSIBLE ?
304
N
ESTABLISH CONNECTION WITH TRANSCODING BETWEEN ENDPOINTS OVER ETHERNET SWITCHING FABRIC
306
Y
ESTABLISH TrFO CONNECTION BETWEEN ENDPOINTS OVER ETHERNET SWITCHING FABRIC IN MEDIA GATEWAY USING SINGLE DSP TO MONITOR AND VARY ENCODING RATES
308

FIG. 3



AMR Rate - 1 at IuUP or NbUP Interface
Ethernet
404
One Codec is used to monitor Rate Change and performing RFCI Mapping.
CODEC/DSP
IuUp/NbUp Stack
RFCI Mapping
IuUp/NbUp Stack
402
400
Less Latency introduced since no Transcoding is involved.
The 2nd codec is not used
Ethernet
404
AMR Rate - 1 at IuUP or NbUP Interface
No Latency introduced since no Transcoding is involved.

FIG. 4

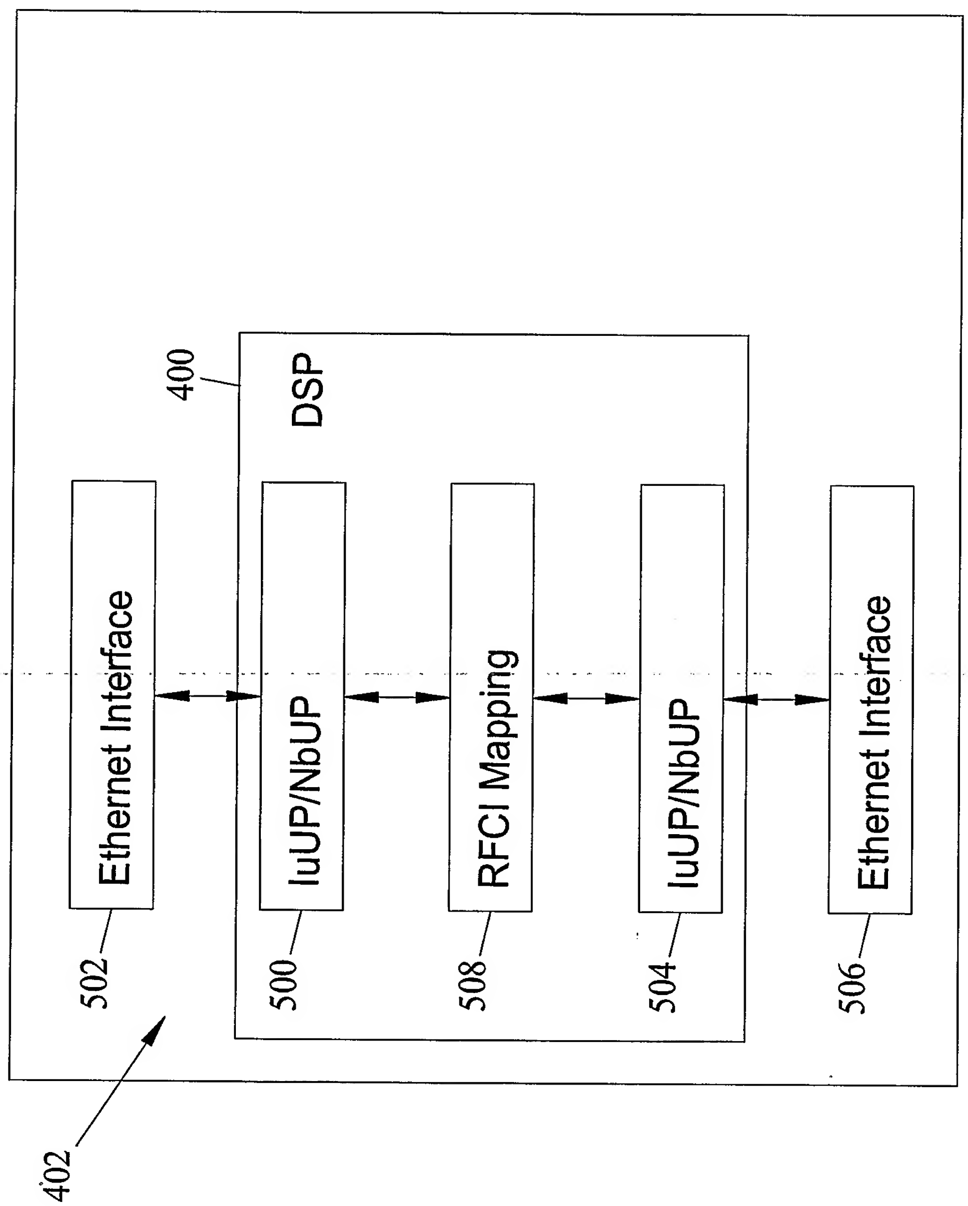

DSP
400
Ethernet Interface
IuUP/NbUP
RFCI Mapping
IuUP/NbUP
Ethernet Interface
502
500
508
504
506
402

FIG. 5

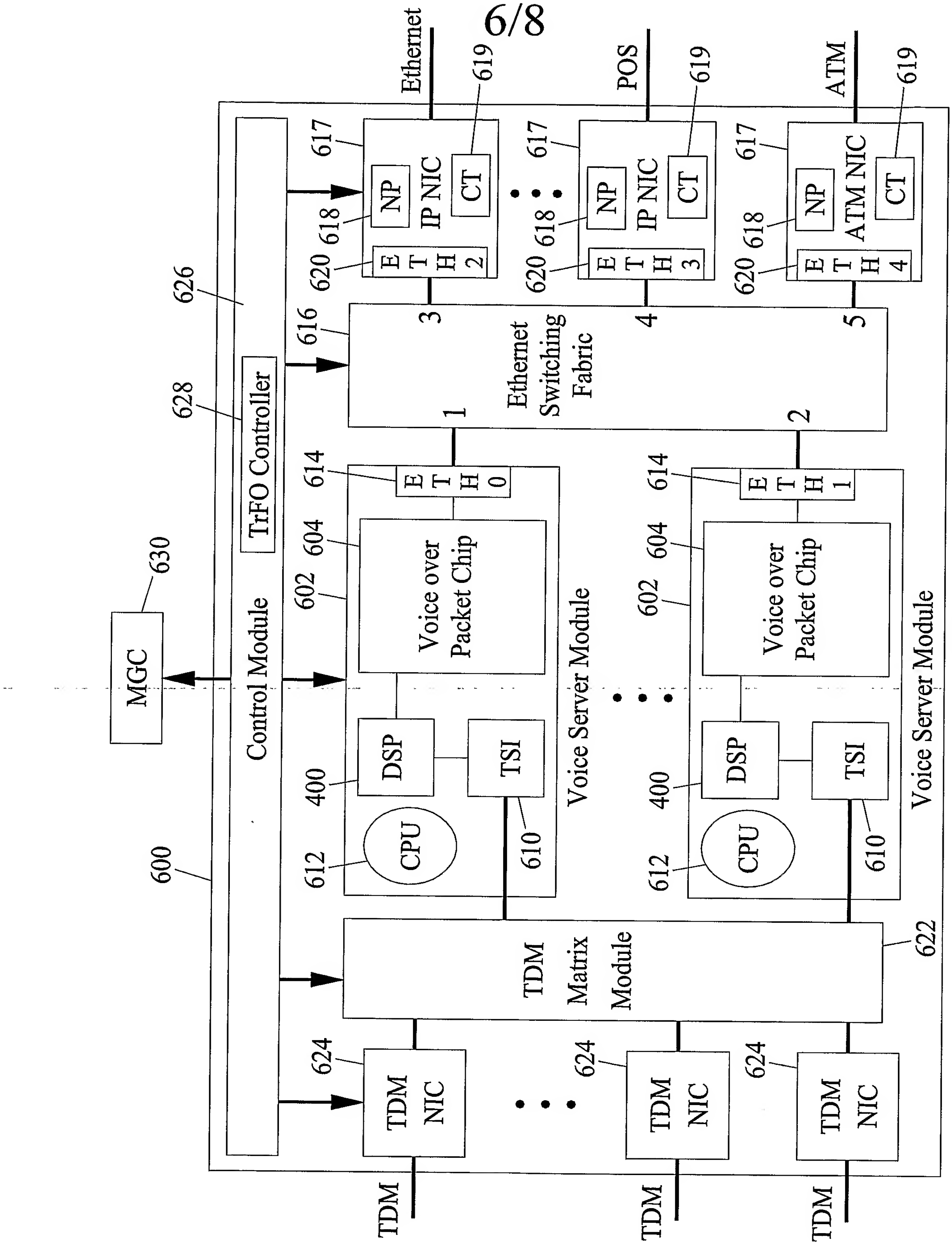

Ethernet
POS
ATM
619
617
618
620
NP
IP NIC
CT
ATM NIC
ETH 2
ETH 3
ETH 4
626
628
616
Ethernet Switching Fabric
3
4
5
1
2
TrFO Controller
614
ETH 0
ETH 1
630
MGC
604
602
Voice over Packet Chip
Control Module
Voice Server Module
DSP
TSI
CPU
400
612
610
600
TDM Matrix Module
622
624
TDM NIC
TDM

FIG. 6

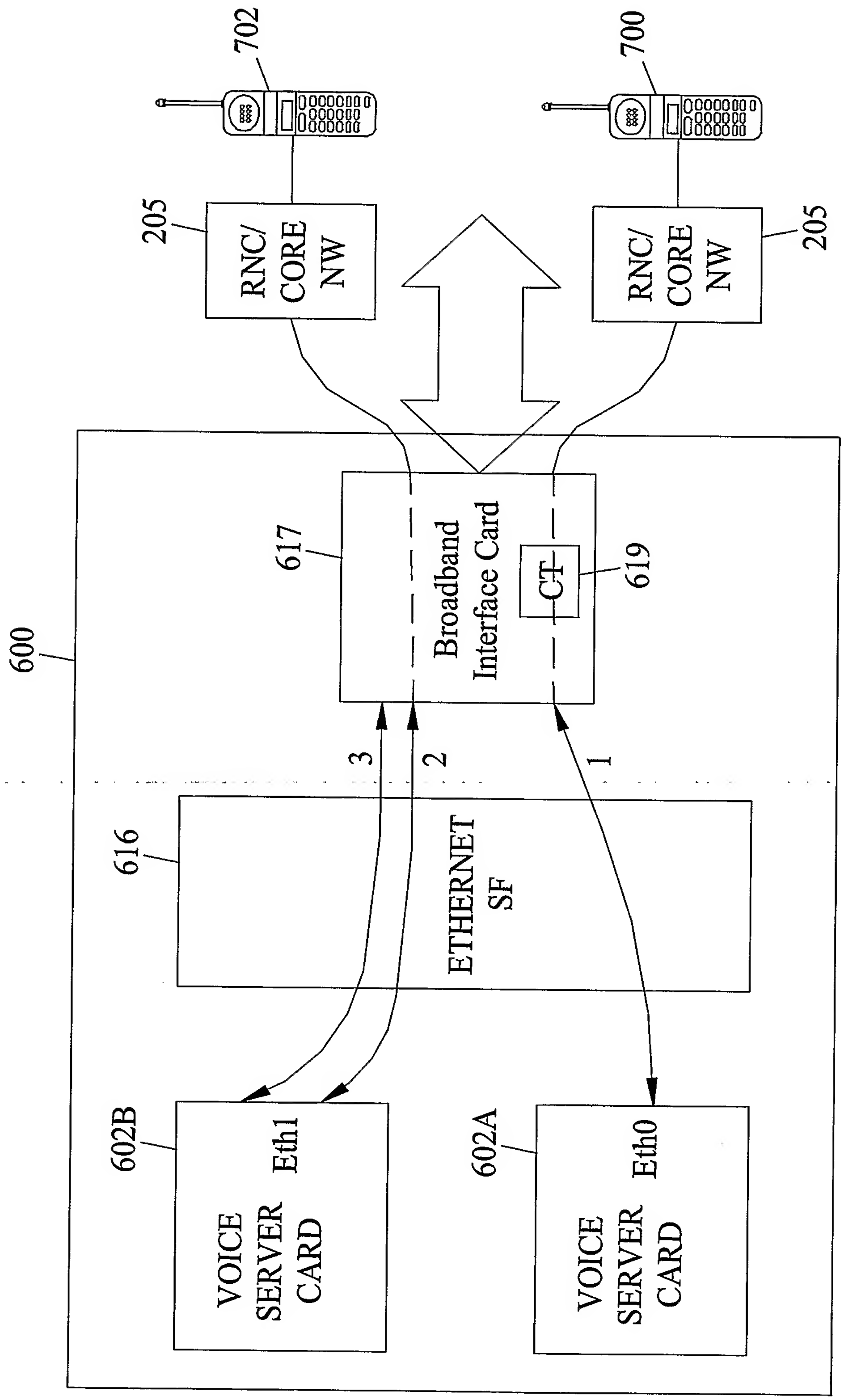

702
700
205
RNC/
CORE
NW
205
RNC/
CORE
NW
205
600
617
Broadband
Interface Card
CT
619
3
2
1
616
ETHERNET
SF
602B
VOICE
SERVER
CARD
Eth1
602A
VOICE
SERVER
CARD
Eth0

FIG. 7

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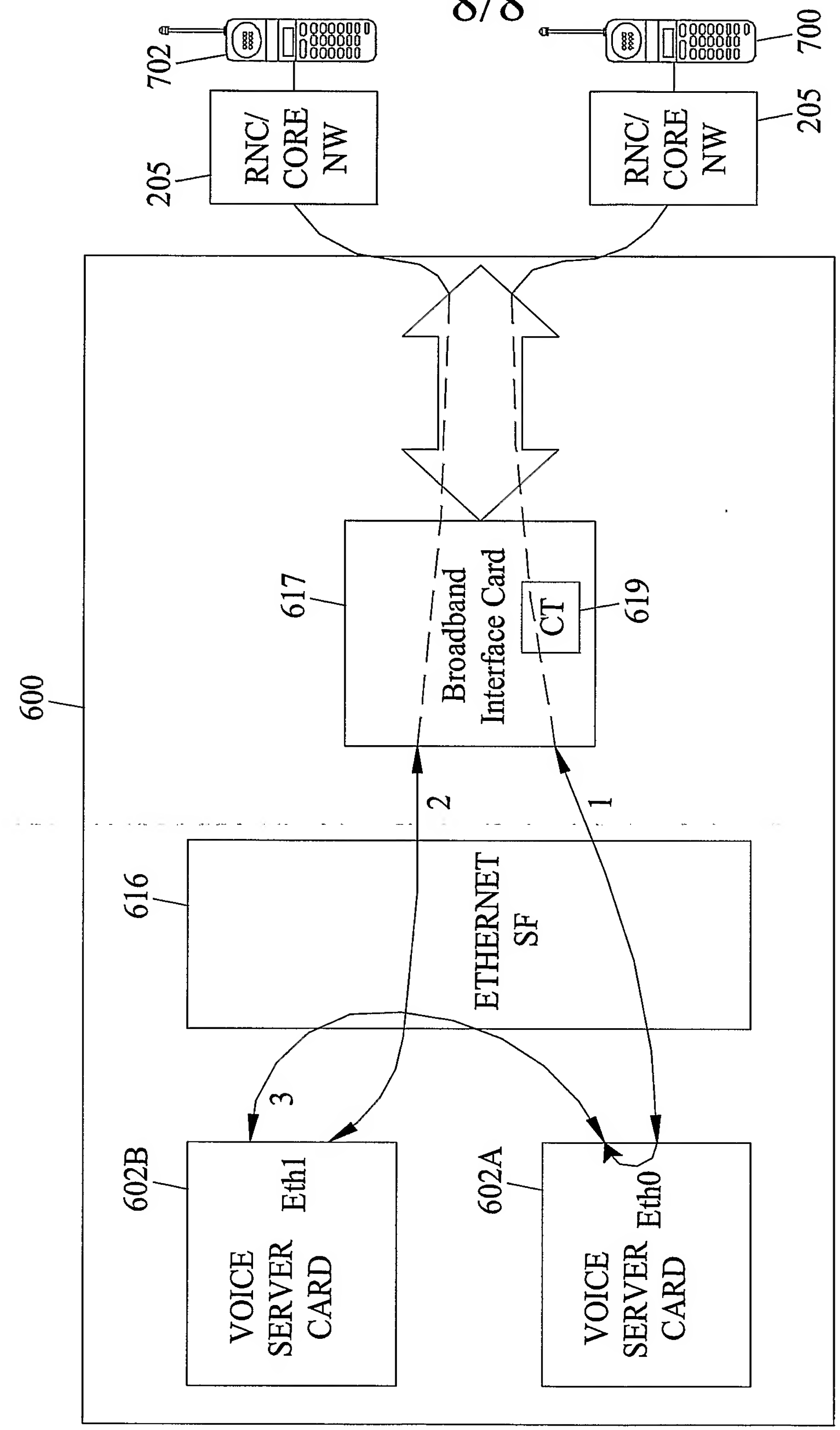
702
700
205
RNC/ CORE NW
205
RNC/ CORE NW
600
617
Broadband Interface Card
CT
619
2
1
616
ETHERNET SF
3
602B
VOICE SERVER CARD
Eth1
602A
VOICE SERVER CARD
Eth0

FIG. 8